CAPPLAN: a decision-support system for planning the pricing and sales effort policy of a salesforce

Sönke Albers
University of Kiel, Kiel, Germany

The problem

If a firm sells a certain product mix through a salesforce to heterogeneous accounts, it is faced with the problem of optimal allocation of selling effort across accounts. Zoltners and Sinha (1980) have surveyed models for aiding this decision, including the popular CALLPLAN model by Lodish (1971). Furthermore, it is a common marketing practice in a variety of industrial and institutional marketing situations as well as in sales of consumer goods within channels of distribution to delegate some price-setting authority to the salesforce (Stephenson *et al.*, 1979). This implies that the salespeople can make use of their specific knowledge regarding the price responsiveness of each customer in order to negotiate customer-specific prices optimally. Lal (1986) presents some detailed examples in which such a differentiation of prices is usual. Now, if sales management has as much information about the selling environment as its salespeople, it has no reason to delegate the pricing responsibility. In this situation, firms need an optimization model for jointly determining price levels as well as selling effort levels. So far, no such model has been proposed in the literature existing on this subject. One reason might be that, under specific conditions, both instruments can be optimized independently (Srinivasran, 1981). If, however, production costs per unit increase with increasing levels of required production capacity, then both marketing instruments become interrelated. To address this problem, the development of the decision-support system CAPPLAN (Call and Price Planning) was undertaken.

The second and third sections of this paper are devoted to a discussion of the proposed response function and the method of estimating its parameters. A formal description of the decision model is then given, and a simple heuristic based on incremental analysis is provided for the resulting optimization task. The paper concludes with experiences from actual application of the system at an industrial photo laboratory offering the development of film and the production of prints through a variety of retailers.

European Journal of Marketing,
Vol. 30 No. 7, 1996, pp. 68-82.
© MCB University Press, 0309-0566

Sales response function

The core element of CAPPLAN is the sales response function dependent on price and the number of calls as operationalization of selling effort. As both instruments should be differentiated across accounts or account groups, CAPPLAN operates with individual response functions. We have chosen a multiplicative, exponentially weighted response function with zero-call sales and asymmetric response to increases and decreases in both price and the number of calls:

$$\underbrace{x_i(h_i, p_i)}_{\text{quantity of sales}} = \Bigg(\underbrace{z_i * S_i}_{\text{current quantity of sales}} + (1 - z_i) * S_i * \underbrace{\left[\frac{h_i}{B_i}\right]^{\beta_i}}_{\text{influence of calls}}\Bigg) \cdot \underbrace{\left(\frac{p_i}{Q_i}\right)^{-\eta_i}}_{\text{influence of price}} \quad (i \in I), \qquad (1)$$

$$\beta_i = \begin{cases} \beta_i^D & \text{if } h_i \le B_i \\ \beta_i^I & \text{if } h_i > B_i \end{cases} \quad (i \in I), \qquad (2)$$

$$\eta_i = \begin{cases} \eta_i^D & \text{if } p_i \le Q_i \\ \eta_i^I & \text{if } p_i > Q_i \end{cases} \quad (i \in I). \qquad (3)$$

I:	Index set of account groups (i: index).
h_i:	Actual mean number of calls for one account of the ith group.
p_i:	Actual mean reference price for the ith account group.
$x_i(h_i, p_i)$:	Quantity of sales with an account of the ith group depending on number of calls h_i and price p_i.
S_i:	Reference (current) quantity of sales with the ith account group as a result of $h_i = B_i$ and $p_i = Q_i$.
B_i :	Reference (current) number of calls for one account of the ith group.
Q_i :	Reference (current) reference price for the ith account group.
z_i, β_i^D, β_i^I, η_i^D, η_i^I r:	Parameters to be estimated that may be interpreted as follows:
z_i :	Fraction of S_i that can be sold without calls ($h_i = 0$) at the current price of $p_i = Q_i$ (zero-call sales).
β_i^D, β_i^I :	Elasticity of effort depending on sales with the ith account group, with respect to a decrease (D) or an increase (I) in the current number of calls.
η_i^D, η_i^I :	Elasticity of sales with the ith account group, with respect to a decrease (D) or an increase (I) in the current price.

In order to avoid complex multi-period, stochastic models, it is assumed that the response is the long-run response and deterministic. Due to the impossibility of observing the selling effort and negotiated prices of competitors, no competitive effect is considered in the response function. All these assumptions are normal within the salesforce literature (Lodish, 1971; Mantrala *et al.,* 1994). Furthermore, the response may have zero-call sales ($z_i \,.\, S_i$) as suggested by Lodish (1971), thereby encompassing the influence of other marketing instruments. Function (1) differs from the one in CALLPLAN (Lodish, 1971) by working with a concave rather than an S-shaped form because it represents the aggregate of individual accounts' sales response functions. Even when the latter are S-shaped, the aggregate response function is approximately concave when effort is always optimally allocated across accounts (Mantrala *et al.*, 1992). The multiplicative form of (1) allows for implicit and symmetric response interaction effects between price and calling effort. A property such as this is necessary because sales losses owing to very high prices cannot be compensated for fully by gains in sales from very intensive calling effort.

Response function (1) offers another attractive property, namely, it always passes through the point currently realized. If $h_i = B_i$ and $p_i = Q_i$, then $x_i(h_i, p_i) = S_i$ by construction. This enables management to compare the current and recommended policies easily, thereby increasing its acceptability. Working with such a functional form also allows for the specification of different elasticities of sales with respect to either a decrease or an increase in the level of the marketing instruments. Such an asymmetric response is described in Simon (1989) regarding the price. Similarly, I have very often found in practical applications that sales management believed that decreasing calling effort would cause more sales variation than increasing calling effort.

To summarize, CAPPLAN is based on a multiplicative, exponentially weighted response function that is very popular in marketing because it is parsimonious, exhibits decreasing marginal returns and allows for a response interaction between marketing instruments (Hanssens *et al.*, 1990). However, it differs from the simple multiplicative functional form by considering a constant sales response to zero-calls, asymmetric elasticities for decreases and increases in marketing instruments and an implicit scaling parameter $\alpha_i = B_i^{-\beta i} . Q_i^{\eta i}$ ($i \in I$).

Estimation of the parameter values

When applying response function (1), the values of its parameters z_i, β_i^D, β_i^I, η_i^D, η_i^I ($i \in I$) must be estimated. In general, the most desirable derivation thereof from observed time series or cross-sectional data (Naert and Weverbergh, 1981) is not possible because the corresponding data are usually not available. This is even more true for experimental data. It is assumed that management has enough experience and intimate knowledge of the market to be capable of estimating the increase or decrease in sales as a consequence of a variation of prices and calling effort (Lodish *et al.*, 1988). Previous studies (Fudge and Lodish, 1977; McIntyre, 1982) have shown that decisions can indeed be improved by systems that rely on subjective estimates, especially if they are used for allocation decisions, which is the case here.

The derivation of the parameter values can be simplified by decomposing the response function into separate functions with respect to price and calling effort. This is possible if one of the instruments is set at its current level, such that the corresponding elasticity expression is equal to one and cancels out. In the case of $h_i = B_i$ we obtain

$$\frac{x_i(P_i)}{S_i} = \left[\frac{p_i}{Q_i}\right]^{-\eta_i} \qquad (i \in I). \tag{4}$$

Here, a response function expressed in relative terms is arrived at, with sales (x_i) relative to current sales (S_i) depending on price (p_i) relative to current price (Q_i). For application purposes, it is proposed to ask the management to give estimates on $x_i(p_i)/S_i$ for at least six price levels (i.e. p_i/Q_i = 80 per cent, 90 per cent, 95 per cent, 105 per cent, 110 per cent, and 120 per cent) while calculating S_i from the firm's internal files. The first three and last three estimates serve as data points for a non-linear regression, to obtain η_i^D and η_i^I, respectively. This constitutes an improvement over more common approaches where the number of point estimates equals the number of parameter values, which always results in a pseudo-perfect fit. Here, the estimation procedure provides 3 (points) – 1 (parameter) = 2 degrees of freedom, so that the error variance and thereby the appropriateness of the function's shape can be assessed (Naert and Weverbergh, 1981).

The isolated response function with respect to calling effort can be obtained by setting $p_i = Q_i$, such that formula (1) simplifies to

$$\frac{x_i(h_i)/S_i - z_i}{1 - z_i} = \left(\frac{h_i}{B_i}\right)^{\beta_i} \qquad (i \in I). \tag{5}$$

Analogous to the estimation of the parameter values of (4), it is proposed again to ask for subjective estimates on $x_i(h_i)/S_i$ for at least six calling effort levels, and to estimate the values of β_i^D and β_i^I from separate non-linear regressions regarding the respective three points of decrease and increase in calling effort. In addition, management must provide input on the relative number of units that can be sold even where the firm reduces its calling effort to zero.

Formal description of the decision model

On the basis of response function (1) with (2) and (3), a decision model is formulated which allows for a differentiation of prices and an allocation of calling effort across groups of accounts. A situation is examined in which there is an already existing salesforce with a given working-time capacity. As decisions on the price levels may have considerable influence on the required production capacity, a corresponding constraint is employed. However, while this capacity can be varied, it causes increasing unit cost c(CAP) over increased production capacity. More formally, we encounter the following profit maximization problem:

$$G(\text{CAP},\text{WT}) = \sum_{i\in I} (p_i - c(\text{CAP})) * \quad x_i(p_i,h_i) \Rightarrow \text{max!} \tag{6}$$

profit parametric in CAP and WT	contribution per unit	quantity of sales

subject to scarce resources:

$$\sum_{i\in I} x_i(p_i,h_i) \le \text{CAP} \qquad \text{(production capacity),} \tag{7}$$

$$\sum_{i\in I} a_i * t_i * h_i \le \text{WT} \qquad \text{(working-time capacity).} \tag{8}$$

In order to obtain meaningful solutions that will be trusted by management, the levels of price and number of calls are constrained between a lower and an upper bound which are not formalized here.

c(CAP): Unit cost function increasing in production capacity CAP.
a_i: Number of accounts composing the ith account group.
t_i: Length of one call to an account of the ith group.
WT: Maximum total working time that can be devoted to calling by all salespeople.

The decision model is formulated for the general case of differentiating prices and calling effort across groups of accounts. In many cases, the number of accounts is too large to allow for the estimation of individual sales response functions per each account. Therefore, the clustering of accounts with similar response functions and the application of the same policy to all accounts with such clusters (groups) is unavoidable. However, the case of individual accounts can be handled by setting $a_i = 1$ ($i \in I$).

The formulation of (6)-(8) shows that the decision maker really faces two different types of problem. For fixed capacity levels CAP and WT, there is an allocation/differentiation problem. Here, only the relative values of the decision variables (price and number of calls) across the different account groups are of interest, given the utilization of a certain capacity level. This is rather an operative planning problem. However, if one intends to vary the levels of CAP and WT, one encounters different absolute values for price and the number of calls for each account group, respectively. This problem has a more strategic character, because it requires the evaluation of investments with long-term effects and side-effects not modelled in (6)-(8). Moreover, the assessment here must be based on less reliable information. Therefore, CAPPLAN offers the option of a parametric optimization, allowing for evaluation of how the differentiation of prices and the allocation of calls change over different capacity levels. This information, then, provides management with the input necessary for deciding on possible investments in the enlargement of the production capacity level.

In the development of CAPPLAN, some trade-offs were made in order to arrive at a decision-support system that can be implemented profitably. First, the response function has a simple functional form and does not allow the exploration of dynamic and competitive policies. Second, the model is formulated at the market segment level, such that it is not possible to consider the combination of accounts into geographical areas that are visited on the same trip. As a consequence thereof, a detailed treatment of travel time and costs is neglected. As long as management does not want to change salesforce size, such a simplification is not crucial, as Lodish (1980) has already pointed out for a similar model for calling-effort allocation. Finally, it must be stressed that c(CAP) may have any shape and is assumed to be a non-convex and non-continuous arbitrary function.

A heuristic procedure for searching for improved solutions

The application of a standard non-linear programming algorithm to our decision problem (6)-(8) appears impossible because the objective function might not be concave, is not differentiable owing to the asymmetric elasticities, and is composed of both continuous variable (prices) and integer variables (number of calls). Although a special, exact optimization algorithm might eventually be constructed, it was decided that a special purpose heuristic which systematically searches for improved solutions should be developed. Because of the requirement for a parametric optimization and the non-convexity of c(CAP), any exact optimization algorithm would have to solve the problem for a large number of discrete levels of CAP, which would consume an unreasonably high amount of CPU-time. Furthermore, management does not intend automatically to apply the solution in practice. Rather, it wants to gain some insight which would be merged with conclusions from other aspects that are beyond the scope of this model. The additional work and cost of exact optimization are therefore difficult to justify, whereas a heuristic provides a better benefit-cost ratio. Parametrically optimal solutions for a whole set of levels of CAP and WT can be provided in an efficient way only by procedures built on the principles of incremental analysis. The basic idea of the heuristic is a decomposition of the decision model into the following two sub-problems:

(1) PRICE: Heuristically differentiates price with number of calls pre-specified by the user;

(2) NCALL: Optimizes the allocation of calls with prices pre-specified by the user.

The incremental analysis in PRICE starts with the highest acceptable price levels per account group, leading to the lowest production capacity requirement. In every iteration, the algorithm searches for the particular price reduction over account groups that offers the highest increase in profit contribution per additional unit of production capacity required. This is executed enumeratively owing to the non-concave and non-differentiable response functions. The procedure continues until all prices have reached their lower bounds.

The incremental analysis in NCALL is similar to PRICE. It starts with the lowest acceptable number of calls per account group, leading to the lowest working-time capacity requirement. In every iteration the algorithm searches for the particular increase in calls over accounts that offers the highest increase in sales volume per additional unit of working-time capacity required. This again is executed enumeratively until the number of calls have reached their upper bounds for all account groups. A detailed description of PRICE and NCALL is provided in an appendix available from the author on request.

A good joint solution can be obtained by alternatively applying PRICE and NCALL with the best found solution of the other procedure, respectively, as pre-specified values. If the current policy as a starting-point is far from optimality, this alternating "optimization" leads to substantial improvements over the starting-point. However, no claim is made about the convergence to the true global optimal solution. In practice, the decomposition into PRICE and NCALL offers management the option to investigate as many combinations of pricing and calling-effort policies as are necessary to gain sufficient insight into the problem and to find a satisfactory simultaneous solution. Such a feature generally facilitates implementation of a decision-support system.

Experience derived from an application

The planning situation

CAPPLAN was developed for a medium-sized industrial photo laboratory in Germany, which offers the development of film and the production of prints through approximately 500 heterogeneous retailers (i.e. specialized photo shops, chemists, department stores, supermarkets) to the consumer.

Over the years, the quality offered by laboratories has become more and more uniform. Furthermore, a rather standardized product of 9 × 13 cm colour prints has evolved. Because of its commodity character, the laboratories felt that pull marketing with the help of advertising was impossible. All attempts at introducing new products in order to avoid strong competition have failed so far. In this situation, management felt that it could compete only on price and service such as quick delivery of processed orders, efficient and generous handling of consumer complaints, and effective consulting of retailers. A neat functioning of the service depends heavily on the frequency of visits (calls) by salespeople. However, the firm under our consideration judged its retailers to be heterogeneous with respect to their response to the number of visits. Some retailers do not pay much attention to the number of calls. Others, working with more than one laboratory at the same time, tend to send most of their orders to the laboratory that is serving them best. Therefore, serving *heterogeneous* retailers means that the time capacity of the salesforce has to be allocated differently across retailers.

Despite competition and a price decay in the last periods, our firm realized that there were some opportunities for active pricing decisions. It came to this conclusion after determining that companies still charge different prices. Although the delivery price cannot be observed directly, a substantial variation therein across retailers was considered to be likely. This was inferred from the fact that retailers generally fix their selling prices according to the delivery price plus relative extra charge (contribution), and these selling prices varied more than 50 per cent. Such differences in price did not seem to be justified by cost differences, but were the result of some kind of "non-transparency" in the market.

Actual price offers could only be acquired via negotiations for which a retailer does not have enough time: there may be thousands of offered items and perhaps more than ten suppliers per item. Again, our firm was convinced that its retailers were heterogeneous with respect to their response to price variations. First, variations of the delivery price are, in general, followed by a corresponding variation of the retailers' price – for which, in turn, the response of the consumers differs according to the retailers' characteristics. Second, retailers who work with multiple laboratories and cannot adjust their selling price will face a decrease in their margin if one of the laboratories increases its delivery price. As a consequence, these retailers will reduce the number of orders to be sent to this laboratory. Third, the likelihood of retailers entirely switching to other laboratories depends on the retailer's size and its competitive situation within its local market. If prices must be negotiated, it is common practice to delegate price-setting authority to the salespeople because they are in the better position to adjust their offers to the respective forecasted responses. However, as already observed by Stephenson *et al.* (1979), salespeople tend to offer prices that are too low. Therefore, management wanted to specify differentiated price levels centrally for similarly responding account groups, so that the actually negotiated prices may not fall short of these specified levels. Such price discrimination is profitable because it extracts all of the retailers' surplus. This is legal in Germany as long as the company does not dominate the market.

In this case, the management of our firm thought it unlikely that small changes in price and selling effort would be observed by competing laboratories, because most retailers would initiate negotiations with competing laboratories only if they faced substantial changes in the previous policies. Furthermore, management assumed that its retailers rarely exchange information concerning prices and the number of visits. Our firm therefore expected that a differentiation of prices and selling effort within lower and upper limits fairly close to the previous policy would not provoke competitive reactions.

Need for decision support

The development of CAPPLAN was initiated by the management of our firm because it judged its current policy to be far from optimum:

- The firm did not follow an active and systematic pricing policy. In the past, the company had lowered prices for the customers individually from time to time when competing offers jeopardized the relationship to a certain customer. As a result, prices did not reflect the supposed response functions. Despite a price decay, management assumed that it was feasible to proactively raise prices once a year and justify such actions by increases in costs. When it came to converting prospects into new accounts, the firm was already operating proactively by establishing price ranges that had to be fulfilled by all offers of the salespeople. In order to improve current practice, it is necessary to base differentiated pricing decisions on the respective sales response functions. Any such attempt will be facilitated by the fact that the firm negotiates only a single price, although it offers a complete product line. This reference price holds for the basic product (9 × 13 cm colour prints), which alone accounts for more than 60 per cent of total sales volume. All other prices are, then, determined according to a fixed relationship to the reference price.
- With respect to selling effort, the firm had been following a very simple policy. All accounts received an equal number of calls with the exception of a differentiation between "old" and new accounts. The number of calls for new accounts was double that for old accounts because the firm had experienced that new accounts terminated their contracts more often than old accounts. The reason was that in the starting period problems with service arose more frequently, which in turn resulted in the termination of a contract unless a salesperson took care of the problems. But now, management had become convinced that sales response functions were significantly different not only between old and new accounts but also across other account segments, such that it would indeed be profitable to explore the advantages of differentiated calling policies.

In addition to these requirements, the firm had to take into account a given production capacity that could only be enlarged if accompanied by increasing unit costs. More precisely, c(CAP) increases to a higher level when exceeding 105 per cent of the current quantity of sales (S_i) because the personnel must then be paid an overtime surplus. After exceeding 110 per cent, 120 per cent and 150 per cent of S_i, respectively, fixed investment costs for enlarging the production capacity must be incorporated into c(CAP). This has been realized by calculating average unit costs for a set of different capacity levels. With this non-continuous unit cost function c(CAP), price and calling-effort decisions become interrelated, resulting in a complex decision-making problem which can be supported profitably by CAPPLAN, especially through its parametric "optimization" option.

Implementation

CAPPLAN, as described so far, has indeed been implemented in the firm under our consideration. This was possible mainly because the decision model (6)-(8) completely reflected the management's understanding of the actual planning situation, the management itself being positively predisposed to more innovative planning tools. Implementation was also advanced by altering the response function's specification until management finally agreed on it, whereby the incorporation of asymmetric elasticities was crucial. Furthermore, it was a clear advantage that, owing to the system's construction, one works with response functions passing through the currently realized point. Thus management could compare easily the profitability of any recommended policy with the current one.

As has already been pointed out by several researchers (Keen, 1975; Little, 1979; Little and Lodish, 1981; Lodish, 1981), the benefits of a decision-support system do not come only from the application of the "optimal" solution but also from various learning processes throughout all phases – from development up to the application of the system. Consequently, the usefulness of a system cannot be evaluated solely in terms of "hard" profit increases. Rather, one needs to take into account "soft" benefits, such as a better understanding of responses after explication of intuitive knowledge, or a new structuring of the perceived decision model after being forced to formalize it. In this particular case, the following "soft" benefits were achieved:

- The requirement of subjectively estimating the response functions initiated a long discussion about the heterogeneity of the various responses. Owing to its heavy workload, management rejected providing individual estimates for about 500 retailers. It agreed instead to search for groups with similar responses. Previously, salespeople only treated "old" and new accounts differently. Now, discussions between salespeople, the respective sales manager and the chairman of the firm revealed that the retailers' responses differed not only between old vs. new accounts, but also across type of retailer (specialized stores, department stores, chemists, supermarkets), size of accounts (A, B, C), and exclusiveness of customer relationship (exclusive orders, split orders). Sales management learned from this exercise that its pricing and calling-effort policy could be differentiated across not just two but 39 different account groups, consisting of three to 40 retailers each. Later, the management expressed that this insight alone would have justified the development cost of CAPPLAN.
- In many cases, estimation of the response functions revealed flat decreases in sales as a result of price increases, suggesting to the management that, after the period of permanent price decay, the market now would be stable enough to accept price increases. However, examining all groups together, the responses indicated too much heterogeneity, so that no such simple policy could be derived. The final

estimates for the individual response functions have been provided by the responsible salesperson and the sales manager. The estimates have been revised until agreement has been reached. As a result, the R^2 of the calibrated response functions was in almost all cases higher than 0.9.

Results

Management initiated the use of CAPPLAN by subsequently applying the subroutines PRICE and NCALL. PRICE was run with the current number of calls, and provided parametrically the best differentiation of price levels for production capacity levels within the interval of 80 per cent to 130 per cent. On the basis of the most profitable price schedule, which required a production capacity of 108 per cent, NCALL was implemented in a second step. It provided the parametrically optimal number of calls per account group for working-time capacity levels within the interval of 50 per cent to 130 per cent (relative to current). The result of this sequential "optimization" process in terms of recommended policy changes is found in Table I.

Table I.
Number of account groups with specific recommendations for the pricing and calling-effort policies

Pricing recommendation	Recommendation regarding calling effort: Decreased number of calls	Same number of calls as before	Increased number of calls	Total
Price decrease	2	2	3	7
Same price as before	2	2	6	10
Price increase	5	12	5	22
Total	9	16	14	39

However, management felt uncomfortable with this solution fearing that the recommended price decreases, although within tight lower bounds, might stimulate the general tendency of a price decay. Therefore, management wished to investigate the possible implications of the best solution found so far – yet without allowing price decreases. In addition, sales management wanted to evaluate a uniform pricing policy that would consist of increases across all account groups. The idea was to operate with a more profitable pricing policy whereby the quantity losses could be compensated by increased effort on the part of the salesforce. As an alternative, management was also interested in reviewing the consequences of doubling its acquisition effort (number of prospects regularly called on). For the resulting six strategies (three pricing strategies × two acquisition strategies) optimal calling-effort levels have been determined. Note that this was only possible as a result of the decomposition of the "optimization" process into the subroutines PRICE and NCALL. The corresponding profit results of these solutions, referring to four different levels of working-time capacity (80 per cent, 100 per cent, 110 per cent and 120 per cent), are found in Table II.

Pricing strategy	Acquisition strategy	Working-time requirements (in % to current workload)	Production capacity requirements (in % to current)	Sales volume (in % to current)	Profit contribution (in % to current)
Optimal prices	Current acquisition effort	76.67 100.81 109.80 121.09	109.92 111.66 112.33 113.15	106.36 108.10 108.77 109.56	109.83 109.06 109.58 110.13
Optimal prices	Doubled acquisition effort	80.69 100.34 112.65 120.02	119.60 122.63 124.91 125.75	113.64 116.69 118.67 119.44	108.55 100.02 100.95 101.42
Optimal prices without decreases	Current acquisition effort	81.13 99.71 111.02 121.76	108.11 109.28 109.66 109.99	105.25 106.57 106.97 107.34	109.92 111.53 112.00 112.41
Optimal prices without decreases	Doubled acquisition effort	80.69 100.28 110.23 120.41	115.86 118.28 119.91 120.49	111.04 113.64 115.08 115.69	108.82 111.18 111.92 101.51
Price increases across the board	Current acquisition effort	79.62 99.56 111.48 122.92	95.43 96.32 96.65 96.86	94.45 95.42 95.81 96.05	101.51 102.70 103.22 103.55
Price increases across the board	Doubled acquisition effort	79.62 101.33 110.93 121.24	97.40 98.66 99.09 99.40	96.06 97.50 97.96 98.32	102.66 104.55 105.10 105.58

Table II. Results of different pricing and acquisition effort strategies

From the results of these "what-if"-runs of CAPPLAN, the firm learned the following more strategic lessons:

- A comparison of the impact of the various policies indicates that profit varies substantially only across pricing policies, but not with respect to an increase in total selling-effort levels. As a result, the firm will be paying attention primarily to a good pricing policy.
- All strategies that lead to substantial increases in the required production capacity turn out to be less profitable. This implies that aggressive growth strategies, like price decreases and increases of acquisition effort, are not preferable. On the other hand, it did not prove to be advantageous to increase prices for all accounts. The resulting loss of quantity of sales cannot then be compensated by corresponding sales increases through more calling effort.
- The most advantageous strategy in Table II entails a constrained differentiation of both prices and calling-effort levels. The restrictions of non-decreases in prices and of remaining at the current acquisition effort

level help to avoid costly production capacity extensions. It should be noted that CAPPLAN predicts an increase in profit of more than 12 per cent for this "best" strategy. This demonstrates that, with the same level of selling effort as before, substantial profit improvements can be achieved by simply differentiating the marketing instruments "optimally" across account groups.

- Increases in workload (total selling-effort level) from 90 per cent to 110 per cent (as compared to current effort) only lead to small increases in quantity of sales and of total contribution. Obviously, the salespeople are operating in the range of flat slopes of their sales response functions. Because a reduction of the number of salespeople was considered impossible, sales management concluded not to change its salesforce size.

Instead of applying the "best" solution directly, the firm implemented a modified policy based on the preceding conclusions. At the beginning of the following year the firm announced price increases – justified by cost increases – to nearly all accounts for which the recommendation was not to decrease prices. This was accompanied by a careful monitoring of the reactions of customers. When there appeared to be a real danger of losing such customers, the firm offered to continue again with the old contract. Instead of reallocating calling time, the firm began to train its salespeople so that they would become able to consult their customers really and properly (retailers). Management thus hoped to increase the previously flat slope of the response function, thereby changing the current calling policy into a more profitable one.

In order to be able to evaluate the usefulness of CAPPLAN better, it would have been preferable to calculate the "hard" benefits in terms of profit improvement induced by the implemented policy. Unfortunately, this would require comparison with a non-implemented policy, which is not possible. From its viewpoint, the firm's management was satisfied with the strategic insights gained from the various runs of CAPPLAN, enabling them to implement an improved policy. The only figure available for judging the usefulness of CAPPLAN was an actual increase in contribution of about 20 per cent which, of course, might have been caused by a variety of other sources: first, price increases were accepted more readily than had been anticipated; second, the firm was not in a dangerous position because most of the competitors also increased their prices; and, third, most retailers experienced gains from a small overall increase in sales volume. Consequently, there was no way to determine the unconfounded effect of CAPPLAN. However, management subjectively estimated that about half of the contribution improvement, namely 10 per cent, may be attributed to the insights gained from using CAPPLAN.

Conclusions

We have described the development and application of the decision-support system CAPPLAN, which provides optimally differentiated delivery prices and calling-effort levels across heterogeneous customers. A joint optimization of these two marketing instruments is necessary if they are coupled via a joint production capacity constraint which can be expanded only at non-linearly increasing unit costs. It has proved to be crucial to the implementation to have spent most of the development effort on the construction of an appropriate sales response function. As a result, management felt confident in subjectively estimating the response parameters and in relying thereon. The management later expressed that, alone, the insights gained from calibrating the response functions would have justified the effort and costs of development. On the other hand, it turned out to be worthwhile not to have invested too much time in the construction of a special-purpose optimization algorithm. The use of a simple heuristic based on incremental optimization principles was judged to be sufficient, since the best solution found predicted a total increase of 12 per cent over current profit contribution. Furthermore, this heuristic allowed for a parametric optimization with respect to different levels of production capacity, such that the impact of extension decisions could be evaluated more accurately. In addition, the heuristic enabled the firm to perform "what if"-runs of CAPPLAN for different pricing and acquisition strategies. The final outcome of the application of CAPPLAN was the implementation of a policy based on strategic insights gained throughout the application process. An evaluation of the profit improvement brought about by this policy was difficult because other factors might have confounded the actual increase of contribution achieved, which as at 20 per cent. It is encouraging that management, based on its own subjective judgement, attributed half of the increase, namely 10 per cent, to the use of CAPPLAN.

References

Fudge, W.K. and Lodish, L.M. (1977), "Evaluation of the effectiveness of a model based salesman's planning system by field experimentation", *Interfaces*, Vol. 8 No. 1, Part 2, pp. 97-106.

Hanssens, D.M., Parsons, L.J. and Schultz, R.L. (1990), *Market Response Models: Econometric and Time Series Analysis*, Kluwer Academic Press, Boston, MA, Dordrecht, London, p. 39.

Keen, P.G.W. (1975), "Computer-based decision aids: the evaluation problem", *Sloan Management Review*, Vol. 16 No. 3, Spring, pp. 17-29.

Lal, R. (1986), "Delegating pricing responsibility to the salesforce", *Marketing Science*, Vol. 5, pp. 159-68.

Little, J.D.C. (1979), "Decision support systems for marketing managers", *Journal of Marketing*, Vol. 43, Summer, pp. 9-26.

Little, J.D.C. and Lodish, L.M. (1981), "Commentary on judgment based marketing decision models", *Journal of Marketing*, Vol. 45, Fall, pp. 24-9.

Lodish, L.M. (1971), "CALLPLAN: an interactive salesman's call planning system", *Management Science*, Vol. 18 No. 4, Part II, pp. 25-40.

Lodish, L.M. (1980), "A user-oriented model for sales force size, product, and market allocation decisions", *Journal of Marketing*, Vol. 44, Summer, pp. 70-8.

Lodish, L.M. (1981), "Experience with decision-calculus models and decision support systems", in Schultz, R.L. and Zoltners, A.A. (Eds), *Marketing Decision Models*, North-Holland, New York, NY, Oxford, pp. 165-82.

Lodish, L.M., Curtis, E., Ness, M. and Simpson, M.K. (1988), "Sales force sizing and deployment using a decision calculus model at Syntex Laboratories", *Interfaces*, Vol. 18, January-February, pp. 5-20.

Mantrala, M.K., Sinha, P. and Zoltners, A.A. (1992), "Impact of resource allocation rules on marketing investment-level decisions and profitability", *Journal of Marketing Research*, Vol. 29, pp. 162-75.

Mantrala, M.K., Sinha, P. and Zoltners, A.A. (1994), "Structuring a multiproduct sales quota-bonus plan for a heterogeneous sales force: a practical model-based approach", *Marketing Science*, Vol. 13, pp. 121-44.

McIntyre, S.H. (1982), "An experimental study of the impact of judgment-based marketing models", *Management Science*, Vol. 28, pp. 17-33.

Naert, P. and Weverbergh, M. (1981), "Subjective versus empirical decision models", in Schultz, R.L. and Zoltners, A.A. (Eds) (1981), *Marketing Decision Models*, North-Holland, New York, NY, Oxford, pp. 99-124.

Simon, H. (1989), *Price Management*, North-Holland, Amsterdam, p. 106ff.

Srinivasan, V. (1981), "An investigation of the equal commission rate policy for a multi-product salesforce", *Management Science*, Vol. 27, pp. 731-56.

Stephenson, P.R., Cron, W.L. and Frazier, G.L. (1979), "Delegating pricing authority to the sales force: the effects on sales and profit performance", *Journal of Marketing*, Vol. 43, Spring, pp. 21-8.

Zoltners, A.A. and Sinha, P. (1980), "Integer programming models for sales resource allocation", *Management Science*, Vol. 26, pp. 242-60.